

## POLICY RESEARCH WORKING PAPER

wps 2458

2458

# Choosing Rural Road Investments to Help Reduce Poverty

*Dominique van de Walle*

A change in the transport sector's current approach to selecting rural road investments is warranted. A proposed approach builds on some of the poverty-focused "hybrid" methods found in recent rural road appraisals—recognizing that an important share of the benefits to the poor from rural roads cannot be measured in monetary terms.

The World Bank  
Development Research Group  
Public Economics  
October 2000



## Summary findings

Van de Walle examines how rural road investment projects should be selected and appraised when the objective is poverty reduction.

After critically reviewing past and current practices, van de Walle develops an operational approach grounded in a public economics framework in which concerns of equity and efficiency are inseparable, information is incomplete in important ways, and resources are limited. She addresses a key problem: that an important share of the benefits to the poor from rural roads cannot be measured in monetary terms.

The selection formula she proposes aims to identify places where poverty and economic potential are high and access is low. She illustrates the method using data for and project experience in Vietnam.

Among the advantages of proceeding as outlined in her proposal: This approach holds the hope of building capacity and is participatory; it extracts local information that may not be readily available to the central government; and it appears to be feasible because it relies on local authorities participating in the appraisal of subprojects.

---

This paper—a product of Public Economics, Development Research Group—is part of a larger effort in the group to study the impact of transport and other physical infrastructure on poverty. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Hedy Sladovich, room MC2-609, telephone 202-473-7698, fax 202-522-1154, email address [hsladovich@worldbank.org](mailto:hsladovich@worldbank.org). Policy Research Working Papers are also posted on the Web at [www.worldbank.org/research/workingpapers](http://www.worldbank.org/research/workingpapers). The author may be contacted at [dvandewalle@worldbank.org](mailto:dvandewalle@worldbank.org). October 2000. (30 pages)

*The Policy Research Working Paper Series disseminates the findings of work in progress to encourage the exchange of ideas about development issues. An objective of the series is to get the findings out quickly, even if the presentations are less than fully polished. The papers carry the names of the authors and should be cited accordingly. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the view of the World Bank, its Executive Directors, or the countries they represent.*

# Choosing Rural Road Investments to Help Reduce Poverty

**Dominique van de Walle\***

*World Bank*

---

\* Development Research Group (DRG) of the World Bank. The paper was in part written while visiting the Université des Sciences Sociales, Toulouse. I would like to thank PREMPO for funding support under its impact evaluation thematic group. I am grateful to DJ Cratty, Ken Gwilliam, Jerry Lebo, Christina Malmberg-Calvo, Martin Ravallion and seminar participants at the World Bank's Economists' week for useful discussions, help and comments on the paper and topic. Email: [dvandewalle@worldbank.org](mailto:dvandewalle@worldbank.org)



## **1. Introduction**

It is widely agreed that the economic appraisal of development projects should help select the projects that contribute most to social welfare. The chosen projects should yield larger gains in social welfare than alternatives. Put in such general terms, the objective is clear enough. But its implementation, and particularly how to measure net benefits, is rarely so clear. This paper focuses exclusively on the appraisal and selection of investment projects in the rural roads sector, where the specific objective is taken to be poverty reduction. This is broadly defined to include relevant non-income dimensions of welfare. How one might go about choosing between road investments is discussed in general terms with some specific illustrations from current work in Viet Nam.

The proposed approach is summarized in Box 1. The proposal recognizes explicitly that an important problem for some types of public spending, including rural roads, is that there is a sizable share of the benefits that cannot be measured in monetary terms so as to be aggregated consistently with monetary measures of other benefits and costs. However, research should at least be able to provide an assessment for a few selected cases, which can provide a benchmark. And there are participatory methods for tapping local information to form judgements of the relative importance of different types of benefits in the specific setting. The proposal in Box 1 tries to use the information available to form a second best appraisal method, taking account of the informational constraints faced in practice.

In the following sections, the paper argues that a change in the transport sector's current approach to rural road investment selection is warranted along the lines described here, building on some of the poverty-focused "hybrid" methods found in recent rural road appraisals at the World Bank and elsewhere.

**Box 1: An appraisal method for rural roads when data are incomplete**

A minimum monetary rate of return is required for rural road investments as a whole, though recognizing explicitly that there are potentially important benefits to which monetary values cannot be assigned. Research from other settings is used to set a benchmark value for the share of benefits from a project that is measured in monetary terms. For example, if research suggests that only two-thirds of the benefits are being captured in the existing cost-benefit calculations and the overall minimum rate of return is 12 percent (when all benefits are monetary and observed) then the minimum monetary rate of return on rural roads is 8 percent. The benchmark is given for each project, though it may be revised in the light of new research.

An initial budget is set, though this may have to be revised in the light of the subsequent appraisal. The budget is to be allocated between many competing road investments. An index of the benefits from a given road link investment is decided on as a weighted mean of various measurable but indicators, with weights reflecting both the expected benefits and how poor the beneficiaries are. The aim is to be comprehensive in identifying benefits, and not to confine attention solely to pecuniary benefits. A participatory, focus group, method is used to determine the weights on different indicators.

All subprojects are then ranked by the ratio of the comprehensive benefit index to their cost. Subprojects are picked with the highest ratios until the initial budget is exhausted.

To assess whether the initial budget allocation was too high or too low, the monetary rate of return calculation comes into play. The narrowly defined monetary benefits are estimated for a random sample of the subprojects selected according to their (comprehensive) benefit-to-cost ratio.

If, given the initial budget, the set of selected projects achieve the pre-determined minimum monetary rate of return then that budget is the final budget. If the monetary return is above (below) the minimum then the budget is increased (decreased) and subprojects are added (deleted) according to their comprehensive benefit measure.

For example, if an extra budget allocation to the sector appears warranted then a fixed increment is set, and one picks the sub-project with the next highest benefit-to-cost ratio, and so on until the increment is absorbed. If the minimum monetary rate of return is achieved for a sample of the newly selected sub-projects then the process stops; if not it continues, adding or deleting subprojects as required.

The paper first critically reviews the methods typically used for selecting roads in Bank-financed projects, both conventional cost-benefit analysis (section 2) and the more recent hybrid methods which combine cost-benefit methods for some projects with cost-effectiveness calculations for others (section 3). Section 4 discusses efforts at quantifying typically excluded benefits. This is followed, in section 5, by an examination of the relevance of the traditional approach in the context of a poor rural economy, using Viet Nam to illustrate the points made. The paper then proposes an alternative approach. Section 6 sets out the problem to be solved. Section 7 presents the proposed methodology and section 8 uses Viet Nam survey data to test the approach's underlying assumption. The paper ends with some concluding comments.

## **2. Traditional Cost-Benefit Analysis of Roads**

There is some research on the importance of infrastructure, and in particular road infrastructure, to agricultural output, economic growth and poverty reduction (including Antle 1983; Binswanger et al. 1993; Chhibber 1989; Jalan and Ravallion 1998; Fan et al., 1999). For example, Jalan and Ravallion (1998) find that road density was one of the significant determinants of household-level prospects of escaping poverty in rural China. However, it is far from clear that existing methods of project appraisal for rural roads will properly reflect the potential benefits to the poor.

Cost-benefit analysis methods for appraising investments in the road infrastructure sector were first developed for roads in more urbanized, high-traffic density areas, drawing on methods from a developed country literature on road appraisal. Traditionally, road investments in World Bank financed projects have been selected based on benefit indicators

derived from consumer surplus calculations of road user savings, comprising both of vehicle operating cost savings and journey time savings. Forecasts of traffic demand—reflecting both normal growth in traffic and that generated by the project—are used to derive willingness to pay estimates to proxy project benefits. Over time, the approach has been implemented at different levels of sophistication, anywhere from only considering benefits accruing to motorized four-wheel vehicles to also including gains to non-motorized traffic and pedestrians based on reduction of travel time savings. In some cases, estimates of the value of agricultural production increases induced by the road investment are also included.<sup>1</sup> The appraisals have generally not made distinctions between beneficiaries from different income or other socioeconomic groups.

A number of criticisms have been leveled at this approach (Hine 1982, Gannon and Liu 1997). One is that it tends to bias investments towards richer areas since the demand for traffic and hence, willingness to pay measures, are higher for the rich. Another is that it is appropriate for high, but not for low traffic areas; and relatedly, that it fails to capture some important, but hard to quantify, benefits from road investments. For these reasons, some observers argued that the method led to under-investment in rural roads and in particular, rural roads serving poorer populations. There are projects that, by conventional cost-benefit analysis, do not have an internal rate of return greater than the critical level (typically set at 12 percent), but yet yield higher social welfare gains than the projects that do pass the test.

In the late seventies, a number of papers inside the World Bank argued for replacing, or supplementing, consumer surplus measures with producer surplus benefit measures for roads where traffic levels are low (see Carnemark et al. 1976, and Beenhakker and Chammari

---

<sup>1</sup> Hine (1982) provides a good discussion of the most commonly used methods of estimating benefits.



1979). The case for a change in focus rested on the induced agricultural developmental impacts of roads not captured by traffic cost savings when traffic is low. Producer surplus estimates aimed to capture gains in agricultural incomes resulting from transport improvements and concomitantly higher farm-gate, and lower input, prices. The aim was to prevent biases caused by sole emphasis on consumer cost savings in predominantly agricultural areas. Complementary agricultural development programs were also emphasized in order to maximize road investment returns (Beenhakker and Chammari 1979).

However, CB analysis as currently practiced in the transport sector is still riddled with problems in how benefits are measured. Valuing benefits for non-market goods for which prices are not known and the consumption of which is subject to quantity constraints is difficult (Cornes 1995). One problem is that there is lack of agreement on the social welfare function that one ultimately bases these valuation judgements on. Conventional CB analysis does not unambiguously answer the question of how much should be spent on rural roads. A fundamental source of the ambiguity has to do with the weights people attach to the multiple objectives of policy. Of course, the road and transport sectors do not face any peculiar problems here. These issues are shared throughout public finance and public policy.

The main problems in conventional methods relate to the systematic exclusion of certain benefits, faulty measurement of the included benefits, and failure to recognize that the assumptions needed to justify ignoring distributional impacts—and so focus solely on efficiency gains—do not hold in practice.

*Excluded benefits:* Conventional appraisal methods, even when combining consumer and producer surplus, are still likely to result in the under-funding of rural roads. Some key benefits such as those accruing to individuals and to society from increased attendance to

schools, health and other facilities rendered accessible by the road investments continue to be omitted. Accompanying distributional benefits are also ignored. Furthermore, there may well be large but omitted risk insurance benefits from linking isolated poorer populations to national transport and communication networks. Quantification of all these benefits remains largely intractable. These omitted benefits would be of less concern if it could be argued that they are positively correlated with the included benefits. However, that is not plausible. Rural roads may well have high omitted benefits but low included benefits. Ranking road investment options in terms of observable benefits may be only weakly correlated with the ranking in terms of total benefit. It appears to be unlikely that conventional methods are a reliable guide to project selection.

*Included benefits:* Current methods of estimating the included benefits are also questionable. Both consumer and producer surplus are problematic as currently measured. Typical consumer surplus calculations for roads tend to exclude consumer gains from changes occasioned by the road in non-transport goods prices. Average daily traffic measures frequently used in forecasting benefits are hard to predict. Similarly, producer surplus measures tend to be incomplete and arbitrary in what is included. Why focus solely on farmers and agricultural produced surplus? Impacts on non-farm employment and other income earning opportunities are typically not factored in. Producer surplus measures also often rely on the same supply response parameters across regions, on spotty production data and make use of averages across income groups not allowing for household and geographic specific factors that influence marginal benefits (van de Walle and Gunewardena 2000).

*Distributional weights:* The use of distributional weights to counter biases against poor areas has tended to be frowned upon within the sector (Gannon and Liu 1997). As

Gannon and Liu state “Economic efficiency is widely accepted as the primary objective of transport sector operations and is used, through cost-benefit analysis, to guide project selection and design” (p. 23). They argue that distributional concerns should be handled at the macro-economic level such as directly through the tax system and, that income distribution decisions are essentially a political responsibility. They also feel that “use of distributional weights is, by and large not appropriate” since they “are subjective, vulnerable to misinterpretation and open to manipulation” (Gannon and Liu 1997, p. 26).

The argument that the transport sector should be geared to maximize efficiency is based on a first best model of the economy: Go for efficiency in production and use redistributive instruments such as the tax system and lump sum transfers to achieve the redistribution objective. There are two problems with this view. First, the objective can be questioned, and second, its implementation in practice. The key assumption underlying the “maximize efficiency” view is that there are other instruments available for meeting the equity objective, so that some sectors such as transport can be left to deal solely with efficiency. Given incomplete markets and limitations on instruments, this assumption fails to hold in practice. If one cannot establish that there already exist the instruments needed for redistribution, and that markets work well, then the maximize efficiency objective becomes unsupportable when equity is valued.

Second, even if we agree that efficiency is the objective of transport investments, benefits must still be measured properly and thoroughly. Otherwise, it is entirely possible that the efficiency objective is not in actual fact being met. It can be persuasively argued that benefits are typically not being thoroughly measured. Indeed, as discussed above, the measurement of benefits has tended to emphasize benefits to the better off and omit those that

favor the poor. In the end, the benefits that one cannot measure appear to be precisely those that accrue to the poor, so achieving the partial efficiency objective may well bias investments against the poor.

Hence in both cases, the bias goes against projects that might directly favor the poor.

### **3. Poverty-Focused Hybrid Methods**

Transport sector experts typically do not make the decisions about how much of the budget should be allocated to the sector, or even across broad within sector categories (such as rural versus urban roads). They are presented with a set budget for investment in rural roads, say, and must then choose what road projects to do. This means that there are ways of choosing projects that allow a more comprehensive assessment of the benefits, but do not claim to measure the social rate of return.

A key difference between cost-benefit analysis (CB) and cost-effectiveness calculations (CE) is that the latter work in a situation where total expenditures for a program are fixed. In such a case, one only needs to decide how to allocate the budget in the best possible way. There is no need to use a consistent metric of benefits that could be the basis for comparisons with other programs or resource uses. Nor is there a need for this benefits indicator to be expressed in monetary units or for it to be comparable with other indicators. The only requirement is to obtain an outcome indicator per amount spent. It is an indicator specific to the particular program and wouldn't necessarily be of interest to any other program. Thus, although CB and CE both measure benefits to cost, the "benefit" units are different. To put the cost-effectiveness indicator in a broader context would require a measure of the social value of the project outcomes in an opportunity cost sense.

A number of projects in the World Bank and elsewhere have turned to cost-

effectiveness calculations to take account of a broader set of benefits—such as potential health and education benefits—yet get around the problem of putting a monetary value on them. The method is sometimes referred to as multi-criteria analysis (Cook and Cook 1990). It has typically been used when traffic volume is too low ( $< 50$  vehicles per day) for conventional consumer surplus measures to make sense, yet, it is strongly believed that there will be important social benefits. In general, a least-cost approach is adopted. A threshold level of costs is arbitrarily designated and project investments costing less are exempt from a conventional cost-benefit analysis that aims to maximize efficiency alone.<sup>2</sup> The eligibility of sub-projects is then subject to “social criteria” such as poverty indicators meeting some pre-determined level.<sup>3</sup> In practice, the “social criteria” are often no more than the number of population in the zone of influence per unit cost. In other cases, potential subprojects are ranked according to indices based on a series of variables deemed to identify needier locations (see, for example, the Zambia project, World Bank 1997).

If one accepts that the project as a whole must reach some minimum internal rate of return (recognizing that this is based on a partial measure of benefits) then it is unclear why one would only measure this for sub-projects above some cost level. There is no reason to suppose that the cheaper projects (of which there may be many) would have the same (conventionally measured) rate of return. So there could well be a selection bias in this method. It would be better to estimate the rate of return to a random sample of sub-projects.

A further concern about past “hybrid methods” is with the benefits measure, which

---

<sup>2</sup> Recent examples include road projects in Peru, Zambia, Andhra Pradesh, and China (World Bank 1995, 1997, 1998a and 1996 respectively).

<sup>3</sup> For example, eligibility under the social criteria for a project in Peru requires that IMRs be over 80, the index of unmet basic needs above 70 percent and beneficiaries be more than 100 per kilometer (World Bank 1995).

tends to be extremely crude. For example, a priori, there can be no assurance that higher population served per unit cost will translate into higher benefits from a road investment. Given identical numbers of potential beneficiaries, it is conceivable that a higher investment cost due to worse terrain could produce considerably higher benefits, as a result of resolving a worse access problem. Furthermore, it is not always clear why some variable is included in the benefit index, and even why it is weighted positively. For example, lower literacy is often treated in this way. Yet, lower literacy in an area might instead be taken as a positive indicator of need (in effect, a distributional weight) or a negative indicator of benefit, assuming that those among the poor who are literate will have the highest marginal gains from access to a road. A sharper conceptual distinction is needed between the 'benefits' and how they are weighted to reflect concerns about distribution.

A final concern is that the process of determining the variables and their weights should more fully exploit the knowledge of local experts and of the poor themselves.

Transport experts can help on technical matters, but are unlikely to be the best people to make the decisions about what information should be included in making a comprehensive assessment of the social gains, and how that information should be aggregated.

#### **4. Assessing the Excluded Benefits from Rural Roads**

Recognizing that some potentially important benefits arising from rural road provision and rehabilitation do not get included by conventional methods of measuring benefits, there have been efforts to quantify social gains and add them to transport cost savings.<sup>4</sup> For example, in attributing education gains it has been assumed that better road access will increase enrolments by an amount derived from mean national rates; previously non-attending children are assumed to complete school, and their life-time earnings predicted based on a comparison of earnings for educated and non-educated individuals nationally. Total additional earnings, appropriately reduced to take account of the costs of education, are then added into the road benefits measure.

Such methods require some strong assumptions. Implicitly, road access is treated as the sole constraint to children attending school. Yet, there could be a host of other contributing reasons that may in turn, partly explain why that particular road has not previously been built. Demand for schooling could be low as a result of high local poverty and the opportunity cost of children's time. Alternatively, there may be cultural reasons keeping girls away, or the returns to education may be perceived to be low, or the quality of the school and teaching may be affecting the schooling decision. Second, the assumption that when these children join the labor market, economic conditions will be identical and that current earnings differentials will subsist is also a strong one.

In attempting to account for these difficult to quantify benefits, it is not uncommon for road project appraisals and impact evaluations to draw on socio-economic indicators across

---

<sup>4</sup> A recent example is South Asia Region, Regional Work Program Agreement: Socio-economic impact of rural access improvements, with emphasis on social impact and poverty alleviation: A regional study with

geographic entities (villages, regions), delineated by whether or not they are serviced by a road, for evidence of such benefits and their magnitude. This is part of the approach intended for the research effort mentioned above within the cost-benefit framework, but this technique is also used as evidence in cost-effectiveness calculations. As is well known from the evaluation literature, however, drawing policy conclusions from such statistics can be misleading (for example, Rosenzweig et al. 1995). Box 2 illustrates the biases that are possible using a simple model in which road placement is endogenous, and based in part on the outcome indicator used for assessing impact. By simply comparing outcomes in villages with roads versus those without, the evaluator can easily conclude that there are large benefits when in fact there are none.

The general point here is that unless road placement is truly random—which seems most unlikely—simple comparisons of outcome indicators in villages with roads versus without them can be very deceptive. Using such data as evidence of benefits without accounting for the process by which the road came to be built in a specific location may lead to very deceptive policy conclusions and decisions. (Indeed, there is nothing preventing a health project from coming along and replacing the ‘with and without road’ to a ‘with and without a health intervention,’ and attributing the same income gains to the health policy.)



**Box 2: Deceptive assessments of the gains from rural roads****Table 1: Mean incomes in villages with and without a road (\$/day/person)**

	Without road (n=56)	With road (n=44)	% increase (t-test)
Case 1: Road yields 20% income gain	1.287	2.413	87% (2.29)
Case 2: Road yields no income gain	1.287	1.976	54% (2.00)

The table shows mean incomes for a group of villages that do not have road access and a group that does. Mean income is much higher for the villages with roads. From such statistics the conclusion is sometimes drawn that the roads generated these large gains—87 percent increase in mean income for one group of villages and 54 percent for the other in this particular case.

However, these numbers were created by a model in which roads generated an income gain of only 20 percent for case 1, and no gain for case 2. The model's pre-intervention incomes were drawn randomly from log normal distributions. Road placement was determined endogenously, as a function of village income (with 25 percent weight) and a second independent log-normal random variable (75 percent). The latter could represent population size, ethnicity, likely votes, historical accident, or any other variable influencing road location by the government. Thus, roads are distributed across villages in terms of a latent variable  $z = .25y + 0.75x$  where  $y$  is log income and  $x$  is the other determinant of road placement. The model gave a road only to villages with positive values of  $z$ .

Of course, the evaluator does not know the true impact of the roads and is tempted to base an estimate on the observed differences in mean incomes between villages with a road and those without. This yields a large over-estimate.

**5. How Relevant is all this to Poor Rural Developing Countries?**

Many of the aforementioned limitations of conventional rural road investment appraisal and selection apply directly to poor, largely rural developing economies. For one, the assumptions underlying the “maximize efficiency” goal are generally not plausible in such settings. There tend to be few other re-distributive instruments such as a tax system. Indeed, we look to sectors such as rural infrastructure and roads to help achieve re-distributive

objectives. In addition, it simply cannot be assumed that investments in rural roads will automatically be pro-poor. Failure to consider the equity objective alongside the efficiency one will thus bias sectoral investments against poorer areas and poor people.

Consumer and producer surplus as conventionally measured appear to be inadequate measures of expected benefits in these settings. For example, in countries such as Viet Nam and the other Asian transition economies it is particularly difficult to predict how agricultural output will alter or how traffic levels will develop given how many factors can begin to change all at once. In many areas, labor and land markets will be newly developing alongside the road investment. Roads have been just one of many constraints to development. We know little about how the rehabilitation of a road link interacted with the other changes in the economy will eventually alter traffic flows and composition, agricultural and other sectoral employment, input and output markets. This may well also be true in more static economies—such as in Sub-Saharan Africa—where, due to a series of other constraints, effects from the road may not be reflected in traffic levels or agricultural productivity for a long time. On the other hand, the argument that there will be substantial pro-poor gains from rural roads which are difficult to measure and to include in conventional CB analysis also holds for most of these rural settings. For these reasons, working within the CE framework and attempting to refine it, appears to be the most appropriate, as well as promising, means of tackling rural road appraisal.

In some countries, assuring minimum access to all may be pro-poor since it is likely that the better-off are well-served by past road investments. Further expansion will thus tend to reach the poor. However, this may not necessarily be the case in the poorest countries. Viet Nam is a case in point. The country had negligible investment in infrastructure for

decades coupled with destructive wars. The road stock remains sparse and in severe disrepair. There has clearly been a tendency to concentrate first on rebuilding higher level networks as opposed to insuring basic access to isolated and poor communes. One would need a very large budget to ensure a level of 'minimum access' to all and yet, the benefits from any lesser goal will tend to be captured by better off areas. It is also necessary to consider that providing road access to isolated, poor communities may be far from a cost effective use of scarce resources for poverty alleviation. Thus, given an objective of raising living standards in a cost-effective way, and given the fixed nature of most rural transport projects—where the total allotted budget for the project is almost certainly not sufficient for ensuring some defined minimum access to all households—a method is still needed for ranking road projects that takes into account both equity and efficiency.

One response to these problems has been to argue that it is really of little consequence in rural developing economies because inaccessibility is an adequate proxy for poverty. It is also strongly implied that high poverty areas have low economic potential. Such convictions underlie the rhetoric and justification for current poverty focused appraisal approaches to rural road projects—whereby, typically, a budget is set aside for non-economic or 'social' objectives, not subjected to ordinary economic analysis, and projects are chosen so as to maximize the population provided with 'basic access' for a cost deemed acceptably low. Under this perspective, the appropriateness of a selection formula that aims to identify places where poverty and economic potential are high and access is low, is open to serious doubts.

This paper argues that if one wants to use a transport intervention to reduce poverty, it seems important to worry about all three factors. Among places where benefits will be high, there are poor and non-poor places; among poor places there are ones where access is

bad and ones where access is already good. A road will not help the poor if they already have good access. Alternatively, in some poor and low access places, the costs far outweigh the potential benefits from improved access. Other interventions— such as facilitating out-migration—are more cost-effective ways to reduce poverty.

Only data can help resolve these conflicts. For example, data can throw light on the argument that the poor are concentrated in areas where access is bad and vice versa. If the empirical evidence supports that view, one variable can be dropped from the formula used to identify appropriate interventions. A commune level data base covering 200 of Viet Nam's communes in six provinces allows an investigation of these issues.<sup>5</sup>

To illustrate the proposed methodology, these data were used to create measures of poverty, inaccessibility and economic potential for each commune. Poverty is represented by an index that combines the rate of infant mortality, the rate of malnutrition for children under 5, and the incidence of hungry households in the commune.<sup>6</sup> Inaccessibility takes into account the existence of passenger and freight transport services, kilometers of commune roads per area, access to different levels of road, railroads, navigable waterways and whether a paved all-weather, or paved sometimes impassable, commune level road runs through the commune. Economic potential reflects population density, agricultural potential (here represented by irrigated agricultural land per capita), the number of social and economic facilities, human capital (percent of children 15 and under who have completed primary school) and number of other development programs. Each of the index components was attributed points reflecting

---

<sup>5</sup> See van de Walle 1999 for a description of the data-base—the Survey on Impact of Rural Roads in Viet Nam (SIRR).

<sup>6</sup> Hungry households are defined nationally as those with the income per person equivalent of less than 13 kg of rice per month. This is a popular and widely collected statistic in Viet Nam

low, medium or high values—determined by the range of the data—for a maximum of 100 points for each index. One can certainly quibble both with the variables included, as well as how they are aggregated. Yet, the general conclusion was not in the least altered by sensitivity tests changing the combination and aggregation of the variables.

The communes were ranked according to each of the three measures. Figure 1 plots the commune rankings by inaccessibility against rankings by poverty; figure 2 does the same for inaccessibility and economic potential; and figure 3 does so for economic potential and poverty. As is readily seen, there is very little correlation between any of these rankings.

These data clearly show that, in Viet Nam at least, one cannot simply reduce the choice to places with poor access, or high poverty, or economic potential. It will be important to figure out how to combine and weight these factors so as to select the places where roads will have the greatest impact on poverty given the cost. Clearly, there are places where inaccessibility, poverty and economic potential are all high, identified by the north-east quadrant in each figure. Project selection needs to be able to identify the intersection of the three. This is where returns to road investments will be highest. Of course, even among these places further choices will exist but they will matter much less.

## **6. The Appraisal Problem Revisited**

Let us assume initially that a fixed budget is available for raising living standards through the rehabilitation of rural road links. How should the budget be allocated? In answering this question, one must consider the allocation between regional entities, such as province, district and commune. And one must consider geographical coverage within each of these levels. In making these choices one wants to assure a cost-effective use of resources, given the overall objective of reducing poverty.

A number of issues arise in addressing this appraisal problem. First, how can we measure expected benefits? This raises the issue of how to account for factors which can be expected to influence the benefit stream, and also attaching some value on those factors to allow a ranking of all potential investment projects. Various transport and existing road attributes (e.g., road density in the area), as well as commune and population characteristics (e.g., human resource development; presence of development projects and complementary infrastructure) will clearly influence the social returns from an investment. But they are likely to do so in differing degrees.<sup>7</sup> This suggests that some kind of weighting scheme must be designed to reflect each factor's significance. How are such weights to be determined?

Another distinct issue concerns how distributional goals are to be incorporated. All else equal, preference should clearly be given to poorer beneficiaries of the transport facilities. This brings up first the question of how "poverty" should be measured. In practice, data availability and comparability across the potential roads' zones of influence, is likely to be the decisive factor. A second issue to be decided relates to what tradeoffs will be accepted

---

<sup>7</sup> Numerous studies have remarked on the key role of complimentary inputs and mediating variables in explaining the gains from a rural road investment. For example, see Hine (1982) and Cook and Cook (1990).

between reaching the poor and other objectives, such as traffic volume.

A final question concerns the ability to centrally appraise all potential road links—that could run to tens of thousands—individually. Is it acceptable to rely on a limited number of “representative” road link appraisals and to extrapolate to other areas? Do alternatives to this common solution exist?

On top of these concerns, there is no guarantee that the initial budget allocation was optimal. Is too much or too little being allocated to the sector as a whole?

The following section proposes one approach to resolving these issues, within realistic information constraints.

## **7. The Proposed Approach**

A total budget  $C$  is available for road rehabilitation investments. It is assumed that there are many road links that are potential candidates for the project and that  $C$  is not sufficient to fund them all. The task of the appraisal is to provide a ranking among these potential links by defining a selection formula that identifies places where poverty and economic potential are high and accessibility is poor. Ultimately, we want a ranking formula that can reflect tradeoffs between these variables and still be implementable.

It is assumed that each road link has a set of encompassing communities ( $EC$ ) and that benefits are confined to those communities. Although this is unlikely to be the ideal way to define a road’s zone of influence, it reflects a pragmatic attempt to resolve the data collection problem. The approach takes advantage of the fact that data is often, and/or more easily, collected at the community level. For data reasons too, inequality within the  $EC$  is ignored—all those within a given  $EC$  are treated the same way. Road links here refer to any

type of road—whether provincial (state), district or commune.

The benefit to a typical user of a proposed link is estimated from data on existing physical infrastructure, human development, economic potential of the region and other factors that may influence the marginal gains from a road investment. One could then calculate total benefit (multiplying by the number of people in the *EC*) and hence the benefit to cost ratio for the link. However, this treats different users in different *EC*'s the same way, and so does not reflect equity concerns. Instead we want to give higher weight to poor users. This is done by attaching a social weight to each *EC*, reflecting how poor residents are on average. Thus a socially weighted benefit-cost ratio is created.

Social welfare (*SW*) is defined as  $\sum S_i B_i N_i$ , where  $S_i$  is the social (equity) value attached to a typical user of the  $i$ 'th link, taken to be the average person living in its *EC*;  $B_i$  denotes the efficiency benefit per person for the  $i$ 'th link; and  $N_i$  is the number of people in the *EC*s of the  $i$ 'th link. Also let  $C_i$  denote the total cost of rehabilitating the  $i$ 'th link (cost per unit length times length).

The problem is then to maximize *SW* subject to  $\sum C_i = C$ . To find the best allocation, all potential road links should first be ranked by the benefit-to-cost ratio:  $S_i B_i N_i / C_i$ . (If  $B_i = B$  for all  $i$ , then the ranking is simply done by  $S_i N_i / C_i$ ). Arbitrary thresholds for different types of roads, or for amounts set aside for the poor, are not required. The same criteria are used for all road links.

If a minimum pecuniary rate of return is also stipulated then this is a further constraint that must be satisfied. If the minimum rate of return condition is not satisfied then one finds the feasible project composition which achieves that rate of return at maximum *SW*, or one spends less than the initial budget. If the constraint is satisfied then that suggests a case for



expanding the initial budget. However, it is essential that the stipulated minimum pecuniary rate of return factors in the existence of non-pecuniary benefits. I will return to this point.

*Benefits and equity weights:* The measure of benefit for the  $i$ 'th road link ( $B_i$ ) is derived from the values of a series of variables  $X_i$  which help determine the average benefit that can be derived from the road investment within the link's  $EC$ s. These include attributes of the road and attributes of the people served. Some factors may lessen benefits, some may increase the stream of benefits. Careful thought needs to go into ensuring that relevant variables are accounted for as much as possible. However, what is considered will ultimately depend on what can be measured at the encompassing community level. Certain factors will be of more consequence to the road benefits, as well as to overall project objectives, than others. For example, we may want to put a higher weight on connectivity to the existing network than to the state of the existing road. Hence a system of weights ( $w_j$ ) needs to be established which reflects the relative importance of each variable in  $X$  in the determination of eventual benefits. So  $B_i = \sum_j w_j X_{ij}$  where  $\sum w_j = 1$ . For each link  $i$ , the weighted values of the  $X$ s are then added up to get a measure of the total expected benefit from the road link. This should then be expressed on a per capita basis.

In a similar fashion, we can postulate that the social weights  $S_i$  are a weighted sum of the values taken by a vector of measurable variables  $Z_i$  describing the socio-economic conditions in the  $EC$  of the  $i$ 'th road link. The poorer the average person in an  $EC$ , the higher the value of  $S$ . Thus,  $S_i = \sum_k v_k Z_{ik}$  where  $v_k$  is the weight attached to the  $k$ 'th factor deemed relevant to the overall social weight, where  $\sum v_k = 1$ .

An important issue is the scaling of  $B$  and  $S$ , since this determines the overall importance attached to equity versus efficiency (as measured by the  $B$ s). This is a value

judgement. One way to decide the issue is to fix the ratio of the maximum  $B$  to the minimum  $B$  and similarly for the  $S$ s.  $B_i$  can be normalized to vary between zero and 100, say. Similarly the minimum  $S$  (for the least poor  $EC$ ) can be set to zero. The decision on the maximum  $S$  (for the poorest  $EC$ ) then determines the relative weight attributed to equity versus efficiency by the formula.

Finally, the resulting measure of benefits is divided by the estimated costs to give a benefit to cost ratio. The costs will vary according to the type of road being rehabilitated and the planned work. The ratios are then used to rank all road link investment proposals. The first disbursement from the budget goes to the link with the highest benefit-cost ratio. The next disbursement goes to the next highest ratio, and so on till the budget is exhausted.

*Minimum rates of return:* Given valuation problems, and since these are worse for certain projects, a key implication is that it cannot be optimal to insist that all projects achieve the same rate of return as required for a public investment with known (measured) benefits. Under the approach common in current practices in the sector, a project must either achieve a certain return or it is taken completely outside the normal evaluation system. In reality, for all projects we should be able to measure some benefits reasonably straightforwardly and some not. Instead of putting certain projects outside the evaluation process, it would be better to explicitly allow for the valuation problems and ensure that all investments achieve a certain minimum rate of return in the measurables. This approach would need to rely on estimates of average non-pecuniary benefits for a broad class of projects probably drawing on evidence in other settings. Proper, careful evaluation based on the latest evaluation best practice, that allows for endogenous placement and, where possible, uses experimental methods, must be undertaken to arrive at benchmark rates of return for different classes of projects. Once we

have an idea of the magnitude of average non-pecuniary benefits and hence internal rates of return from the investments, we can set the measurable rate of return cutoff points.

Recognizing our lack of knowledge in this area will add impetus towards resolving the issue in a believable way taking proper account of biases such as due to the endogeneity of program placement (as discussed above). This means setting up focused and rigorous research projects that aim to cover enough project types to provide an idea on various non-pecuniary benefits.

There are a number of judgements that will need to be made to implement the above approach, notably in setting the various weights (including the overall weight on equity versus efficiency). The next section will suggest how well-informed judgements, consistent with social values in each setting, might be formed in practice.

## **8. Putting the Approach into Practice<sup>8</sup>**

The following gives a step by step example of possible implementation in Viet Nam. Obviously, it is important to be flexible and allow for institutional and other local constraints in implementation. The approach needs to be piloted, revised after a first cycle and altered in the light of experience. All players must be willing to accept set-up costs including the time necessary for data collection and analysis, and for all project proposals to be made.

A fixed budget is available for the rehabilitation of rural road links. All provinces (covered by the project) compete for this budget. The specific variables and their weights are devised by the project team in collaboration with the government. The idea is to then

---

<sup>8</sup> This section elaborates on an actual example from a recent World Bank project. Some points have been developed further than in the project for expository reasons.

decentralize the formula to the provinces that will be responsible for making proposals and bid for the money. The steps are as follows:

Step 1: Availability of data at the commune/district level and an extensive consultative process allows the Bank and the transport ministry teams to delineate a set of  $X$ s—encompassing commune and road characteristics—that must be taken into account in estimating expected efficiency benefits.<sup>9</sup> A potential list of the variables that determine efficiency gains might include the following:

Road density in area; Local human resource development: as measured, say, by percent of children completing primary school; Other (complementary) development projects in area; Accessibility to social service facilities; Accessibility to other forms of transport (train, waterways); Agricultural development potential as measured, say, by unused land with agricultural potential; Current road condition; Linkages with the existing network of roads.

Step 2: Next the scale and key variables determining the imputed social value of the benefits from a link must be determined. From the point of view of the project objectives, the poverty level is an important characteristic of  $EC$ s. Ideally, poverty data by commune would be available centrally. Data often exist at commune or district level but there is no system to compile it nationally. One possibility is to rely on the provinces to come up with an internal poverty ranking of their communes based on a composite index of variables ( $Z$ ) influencing  $S_i$ , the content and scale of which is decided centrally. For example, this could include IMRs, average incomes, literacy, share of school-age children attending secondary school, under-nutrition, etc. Since such indicators are typically expressed in different units, a different scale

---

<sup>9</sup> A number of variables that help determine the efficiency gains might also enter the equity weights, possibly with the opposite sign! For example, there is evidence of significant complementarities between physical and human infrastructure investments (for example, van de Walle 2000). Thus, it is likely that the marginal benefits from a road project will be higher in areas where education and health status are higher. On the other hand, one might want to favor  $EC$ s with lower human capital, and hence welfare, with a higher distributional weight.

must be determined so that the numbers can be added up (note that this applies also to the  $X$ s). Most communes report such data to the district. The province authorities should then be able to collect the information from each of their districts.

Step 3: To determine the weights on the variables in  $B$  and  $S$ , and the value of the scale for the poorest  $EC$  relative to the least poor and hence the scaling of equity versus efficiency concerns, a multi-disciplinary group of Government and non-government Vietnamese experts can be set up to define the weights by consultative process. The Bank team can design and participate in a meeting to do this. Possibly separate meetings will be needed for  $S$  and  $B$ . By relying on a commission of local experts, it is expected that the measurement of benefits will adequately reflect societal values.

Step 4: A technical assistance team should be provided to each province for a certain amount of time to explain the rules of the game, help make project plans, comment on the shelf of possible projects, etc. It will also explain that validation checks will be made.

Step 5: All provinces produce proposals. The methodology is applied to all types of roads. The provinces must carefully weigh the costs of spot repairs, versus rehabilitation, versus full upgrading in making their proposals. Each province draws up a list of benefits and costs for all road links put forward as potential sub-projects. The process should allow for proposals that include more than one road link, and possibly combinations of different levels of road links. For example, a benefit-to-cost ratio calculation could be based on a network of 2 or more contiguous links where it is persuasively argued that the benefits from one link are considerably higher if the other link is also rehabilitated. The technical team will be responsible for explaining this and extending assistance to the provincial teams.

Step 6: Since the formula is fully decentralized it would be desirable to introduce

incentives to play according to the rules. Validation of the province assessments of numbers can be made on a random basis. A province that is found to have cheated is punished. Punishment can consist of being thrown out of the game, or face some appropriate penalty such as a tax on its costs.

Step 7: The money is allocated to provinces according to the lists. The first unit of money goes to the highest benefit for cost “sub-project”; the second to the next and so on. One potential issue is that of the cross-province funding distribution. It is conceivable that the best projects will be concentrated in a few provinces. If this is a concern there are a number of ways to prevent this eventuality. It might be specified that the second pot of money must go to a different province from the first, and so forth, to avoid all the money ending up in only a few places. Or it may be decided that each province originally selected to participate must get a minimum of the total, (say  $1/60^{\text{th}}$  in the case where 30 provinces are participating). Alternatively, a formula could be determined by which one half of the entire budget is allocated in proportion to province population size, or population and a provincial index of inaccessibility and poverty, leaving the rest to be allocated according to where the most cost-effective links are proposed. Either way, the money is still allocated according to the lists of rankings. If the minimum allocation has been reached for each province, we stop. If not, then we will need to go back to the list and go through a process whereby the last chosen link is dropped and (unless it is located in the under-funded province) replaced by the link with the highest cost/benefit ratio from the under-funded province, and so on.

Step 8: For a representative project within each of the main road types, a conventional internal rate of return calculation is made based on producer and consumer surpluses. This is used to estimate the overall rate of return to the set of sub-projects selected up to Step 7. A

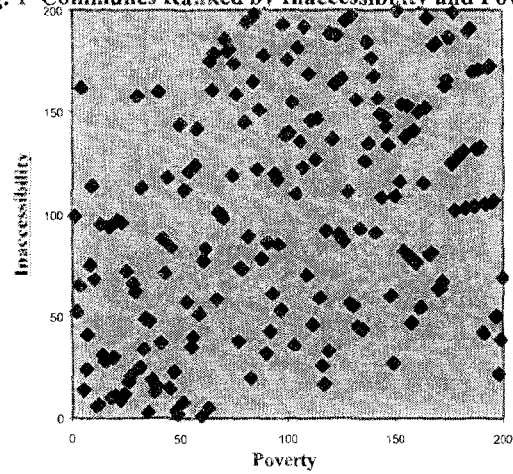
minimum return that is adjusted for expected non-pecuniary benefit levels is determined. If the average rate of return is at or above the minimum then one stops. If, however, it is below the minimum, then one has to substitute projects that had not previously been included for some that had. Thus substitution should be made so as to assure the least cost in terms of the more comprehensive measure of benefits used in selecting projects. The project with the lowest benefit-cost ratio in the road type category with the lowest rate of return should be dropped and replaced by the project with the highest ratio amongst those previously rejected. This continues until the minimum rate of return is reached.

## **9. Concluding Comments**

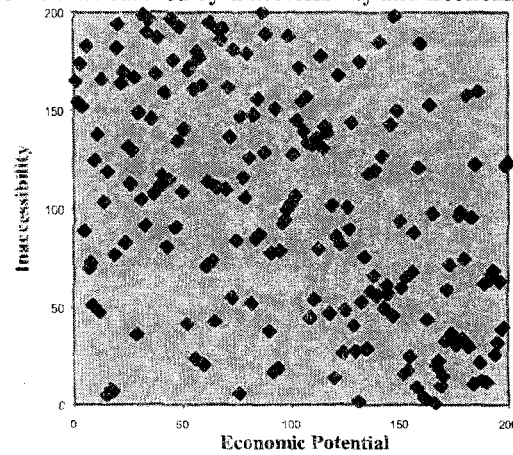
The approach proposed here builds on a number of past approaches, observations and project experience. The aim has been to focus the discussion back squarely on the poverty objective, but doing so within a public economics framework in which efficiency and equity concerns are inseparable, information is incomplete in important ways, and resources are limited. The approach tries to avoid the tendency to treat budgets for so-called 'social objectives' outside the realm of hard-nosed economic analysis, but also recognizing the constraints faced in practice in implementing rigorous appraisal with limited information.

The advantages of proceeding as outlined in this proposal include that it holds the hope of building capacity, and is participatory; it extracts local information that may not be readily available to the center; and it appears to be feasible through its reliance on the participation of local authorities in the appraisal of sub-projects. The method promises to assume that the most effective investments are selected from the point of view of poverty reduction, given both the information and resource constraints.

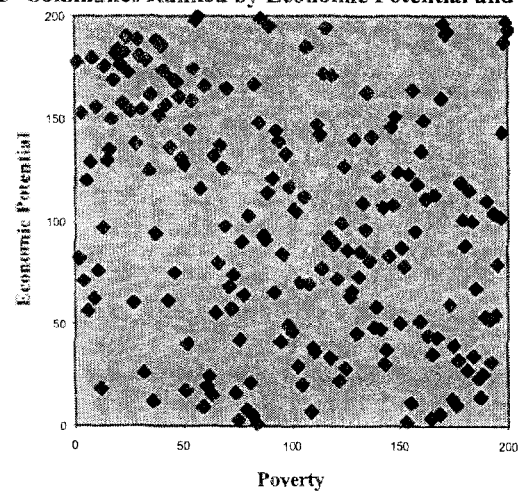
**Fig. 1 Communes Ranked by Inaccessibility and Poverty**



**Fig. 2 Communes Ranked by Inaccessibility and Economic Potential**



**Fig. 3 Communes Ranked by Economic Potential and Poverty**





## References

- Antle, J.M. 1983 "Infrastructure and Aggregate Agricultural Productivity: International Evidence" *Economic Development and Cultural Change* 31(3): 609-19.
- Beenhakker, Henri and Abderraouf Chammari. 1979. "Identification and Appraisal of Rural Roads Projects," World Bank Staff Working Paper No. 362, World Bank, Washington, D.C.
- Binswanger, Hans, Shahidur Khandker, and Mark Rosenzweig. 1993. "How Infrastructure and Financial Institutions Affect Agricultural Output and Investment in India." *Journal of Development Economics* 41(2): 337-66.
- Binswanger, Hans. 1990. "The Policy Response in Agriculture." In Proceedings of the World Bank Annual Conference on Development Economics 1989, 231-258, World Bank, Washington, D.C.
- Carnemark, Curt, Jaime Biderman and David Bovet. 1976. "The Economic Analysis of Rural Road Projects." World Bank Staff Working Paper No. 241, World Bank, Washington, D.C.
- Chhibber, Ajay. 1989. "The Aggregate Supply Response--A Survey," in Commander, Simon. (ed.), *Structural Adjustment and Agriculture: Theory and Practice in Africa and Latin America*, 55-68, London: Overseas Development Institute.
- Cook, Peter and Cynthia Cook. 1990. "Methodological Review of Analyses of Rural Transportation Impacts in Developing Countries." *Transportation Research Record* 1274: 167-78.
- Cornes, Richard. 1995. "Measuring the Distributional Impact of Public Goods." In van de Walle, Dominique and Kimberly Nead (eds.), *Public Spending and the Poor: Theory and Evidence*, 69-90, Johns Hopkins University Press: Baltimore.
- Fan, Shenggen, Peter Hazel and Sukhadeo Thorat. 1999. "Linkages Between Government Spending, Growth and Poverty in Rural India." Research Report 110, International Food Policy Research Institute, Washington DC.
- Gannon, Colin and Zhi Liu. 1997. "Poverty and Transport." TWU discussion papers. TWU-30, World Bank, Washington, DC.
- Hine, J.L. 1982. "Road Planning for Rural Development in Developing Countries: A Review of Current Practice." TRRL Laboratory Report 1046, Overseas Unit, Transport and Road Research Laboratory, Crowthorne, Berkshire, U.K.
- Howe, John. 1983. "Conceptual Framework for Defining and Evaluating Improvements to Local Level Rural Transport in Developing Countries." Intermediate Technology Transport Ltd., Ardington, U.K.
- Jalan, Jyotsna and Martin Ravallion. 1998. "Geographic Poverty Traps?" Institute for Economic Development, Discussion Paper 86, Boston University.
- Kilkenny, Maureen. 1998. "Transport Costs and Rural Development," *Journal of Regional Science*, 38(2): 293-312.

- Riverson, John, Juan Gaviria, and Sydney Thriscutt. 1991. "Rural Roads in Sub-Saharan Africa: Lessons from World Bank Experience." World Bank Technical Paper No. 141, Africa Technical Department Series, Washington, D.C.
- Pitt, Mark, Mark Rosenzweig and Donna Gibbons. 1995. "The Determinants and Consequences of the Placement of Government Programs in Indonesia." In Dominique van de Walle and Kimberly Nead (Eds.) *Public Spending and the Poor: Theory and Evidence*, Johns Hopkins University Press: Baltimore.
- van de Walle, Dominique. 2000. "Are Returns to Investments Lower for the Poor? Human and Physical Capital Interactions in Rural Viet Nam." ARQADE, University of Toulouse, France. Processed
- van de Walle, Dominique. 1999. "Assessing the Poverty Impact of Rural Road Projects." World Bank, Development Research Group, Washington, DC.
- van de Walle, Dominique and Dileni Gunewardena. 2000. "Does Ignoring Heterogeneity In Impacts Distort Project Appraisals? An Experiment for Irrigation in Viet Nam." *World Bank Economic Review*, forthcoming.
- World Bank. 1995. Staff Appraisal Report: Peru Rural Road Rehabilitation and Maintenance Project. Report No. 14939-PE, World Bank, Washington, D.C.
- World Bank. 1996. Staff Appraisal Report: China, Second Henan Provincial Highway Project. Report No. 15358-CHA, World Bank, Washington, D.C.
- World Bank. 1997. Staff Appraisal Report: Republic of Zambia, Project to Support a Road Sector Investment Program. Report No. 16539-ZA, World Bank, Washington, D.C.
- World Bank. 1998a. "Economic Analysis for the Rural Road Component: Andhra Pradesh Economic Rehabilitation Project, India." Infrastructure South Asia Region, World Bank, Washington, D.C.
- World Bank. 1998b. Vietnam Rural Transport Project II: Project Concept Document, Sept 4. World Bank, Washington, D.C.

# Policy Research Working Paper Series

Title	Author	Date	Contact for paper
WPS2442 A Firms's-Eye View of Policy and Fiscal Reforms in Cameroon	Bernard Gauthier Isidro Soloaga James Tybout	September 2000	L. Tabada 36896
WPS2443 The Politics of Economic Policy Reform in Developing Countries	Richard H. Adams Jr.	September 2000	M. Coleridge-Taylor 33704
WPS2444 Seize the State, Seize the Day: State Capture, Corruption, and Influence in Transition	Joel S. Hellman Geraint Jones Daniel Kaufmann	September 2000	D. Billups 35818
WPS2445 Subsidies in Chilean Public Utilities	Pablo Serra	September 2000	G. Chenet-Smith 36370
WPS2446 Forecasting the Demand for Privatized Transport: What Economic Regulators Should Know, and Why	Lourdes Trujillo Emile Quinet Antonio Estache	September 2000	G. Chenet-Smith 36370
WPS2447 Attrition in Longitudinal Household Survey Data: Some Tests for Three Developing-Country Samples	Harold Alderman Jere R. Behrman Hans-Peter Kohler John A. Maluccio Susan Cotts Watkins	September 2000	P. Sader 33902
WPS2448 On "Good" Politicians and "Bad" Policies: Social Cohesion, Institutions, and Growth	Jo Ritzen William Easterly Michael Woolcock	September 2000	A. Kibutu 34047
WPS2449 Pricing Irrigation Water: A Literature Survey	Robert C. Johansson	September 2000	M. Williams 87297
WPS2450 Which Firms Do Foreigners Buy? Evidence from the Republic of Korea	Caroline Freund Simeon Djankov	September 2000	R. Vo 33722
WPS2451 Can There Be Growth with Equity? An Initial Assessment of Land Reform in South Africa	Klaus Deininger Julian May	September 2000	33766
WPS2452 Trends in Private Sector Development in World Bank Education Projects	Shobhana Sosale	September 2000	S. Sosale 36490
WPS2453 Designing Financial Safety Nets to Fit Country Circumstances	Edward J. Kane	September 2000	K. Labrie 31001
WPS2454 Political Cycles in a Developing Economy: Effect of Elections in Indian States	Stuti Khemani	September 2000	H. Sladovich 37698

# Policy Research Working Paper Series

Title	Author	Date	Contact for paper
WPS2455 The Effects on Growth of Commodity Price Uncertainty and Shocks	Jan Dehn	September 2000	P. Varangis 33852
WPS2456 Geography and Development	J. Vernon Henderson Zmarak Shalizi Anthony J. Venables	September 2000	R. Yazigi 37176
WPS2457 Urban and Regional Dynamics in Poland	Uwe Deichmann Vernon Henderson	September 2000	R. Yazigi 37176